Social inhibition and emotional distress in patients with coronary artery disease

Timmermans, I.A.L.; Versteeg, H.; Duijndam, S.N.C.; Graafmans, C.; Polak, P.; Denollet, J.

Published in:
Journal of Health Psychology

DOI:
10.1177/1359105317709513

Publication date:
2019

Document Version
Publisher's PDF, also known as Version of record

Article

JHP

Journal of Health Psychology
1–16

DOI: 10.1177/1359105317709513
journals.sagepub.com/home/hpq


Social inhibition and emotional distress in patients with coronary artery disease: The Type D personality construct

Ivy Timmermans[1,2], Henneke Versteeg[2], Stefanie Duijndam[1], Corine Graafmans[1], Peter Polak[3] and Johan Denollet[1]

Abstract

We examined the validity of the social inhibition component of Type D, its distinctiveness from negative affectivity, and value regarding emotional distress as measured with the DS14 in 173 coronary artery disease patients. In dimensional analysis, social inhibition and negative affectivity emerged as distinct traits. Analysis of continuous negative affectivity and social inhibition measures showed main effects for several emotional and inhibition markers and an interaction effect for social anxiety. Categorical analysis indicated that Type D patients reported more depression, negative mood, social anxiety, and less positive mood. Social inhibition is not a redundant trait, but has additional conceptual value.

Keywords

coronary artery disease, emotional distress, social inhibition, Type D personality

Introduction

In the past decades, research has been performed on the distressed (Type D) personality profile as a vulnerability factor for emotional distress and adverse cardiovascular outcomes in patients with coronary artery disease (CAD; Denollet, 2013). The Type D personality profile is characterized by high levels of negative affectivity and social inhibition. Negative affectivity refers to the tendency to experience feelings of dysphoria, anxiety, and irritability, and social inhibition refers to the tendency to inhibit emotions and behavior in social interaction (Denollet, 2005). The relationship between Type D and emotional distress (e.g. depression, anxiety) is of great importance, since emotional distress is known to be associated with adverse cardiovascular outcomes (Frasure-Smith and Lespérance, 2008; Kubzansky et al., 2006; Roest et al., 2010). Social inhibition seems to be associated with increased cardiovascular risks as well, although evidence is less compelling. Some large prospective studies have found associations between social anxiety/insecurity

[1]Tilburg University, The Netherlands
[2]University Medical Center Utrecht, The Netherlands
[3]St. Anna Hospital Geldrop, The Netherlands

Corresponding author:
Ivy Timmermans, Center of Research on Psychology in Somatic diseases (CoRPS), Tilburg University, Warandelaan 2, 5037 AB Tilburg, The Netherlands.
Email: i.a.l.timmermans@uvt.nl

and hypertension (Räikkönen et al., 2001) and susceptibility to myocardial infarction (Shen et al., 2008), and between social avoidance and cardiovascular morbidity and mortality (Berry et al., 2007).

Meta-analyses have shown that Type D personality is associated with an increased risk of cardiovascular events in patients with CAD (Denollet et al., 2010; Grande et al., 2012), but there are studies reporting null findings in patients with heart failure and other cardiac conditions (Coyne et al., 2011; Grande et al., 2011; Pelle et al., 2010). The association of Type D with mortality was no longer significant after adjustment for depression in one study (Dulfer et al., 2015), while Type D still predicted adverse events after adjustment for depression in other studies (Denollet et al., 2010). These worse health outcomes in patients with Type D personality may be explained by biological and behavioral mechanisms, including smoking, poor diet, and lower levels of self-efficacy (Booth and Williams, 2015; Wiencierz and Williams, 2016; Williams et al., 2016).

Over the past few years, there has been a debate concerning the validity of the Type D personality construct, in particular of the social inhibition component (Grande et al., 2010). Some have argued that social inhibition is merely an epiphenomenon of negative affectivity, being artifactual in the relationship between Type D and CAD outcomes (Ketterer, 2010). Additionally, the position of Type D personality within the five-factor model of personality shows that both negative affectivity and social inhibition were positively correlated with neuroticism and negatively with conscientiousness and extraversion (De Fruyt and Denollet, 2002). However, more recent evidence suggests that social inhibition interacts with negative affectivity to predict adverse events in patients with CAD (Denollet et al., 2013), and factor analytic studies have shown that social inhibition is distinguishable from negative affectivity and depression in healthy individuals (Beutel et al., 2012; Kudielka et al., 2004) and cardiac patients (Kupper et al., 2013; Pelle et al., 2009). Nevertheless, more research is needed to further investigate the validity of the social inhibition component of Type D personality.

Therefore, the aim of this study was to enhance knowledge about the content and distinctiveness of the social inhibition construct, by investigating its associations with emotional distress and inhibition markers in CAD patients. Social inhibition was analyzed at *dimensional*, *continuous*, and *categorical* levels within the context of the Type D personality construct. Dimensional and continuous analyses of Type D personality traits imply a variable-centered approach, which assumes that the population is homogeneous with respect to how these traits operate on outcomes (Laursen and Hoff, 2006). A categorical analysis of Type D is based on a person-centered approach that aims to identify groups of individuals who share particular attributes (Laursen and Hoff, 2006). In some studies, both continuous and categorical measures of Type D were associated with adverse outcomes (Denollet et al., 2013), while in others only categorical Type D measures were associated with outcomes (Dulfer et al., 2015; Wang et al., 2016). It is important to take both variable-centered and person-centered approaches into account, since these complementary approaches both capture unique information. Therefore, it may have practical and theoretical benefits to use both approaches simultaneously in personality research.

In this study, we analyzed Type D scores according to the recommendations of Smith (2011). First, we used exploratory factor analysis to examine the two-factor structure of the Type D construct as defined by its distinct social inhibition and negative affectivity components (dimensional approach). Second, we examined the main and interaction effects of social inhibition and negative affectivity as a vulnerability factor for emotional distress (continuous approach). Third, we examined personality prototypes based on combinations of high and low levels of social inhibition and negative affectivity as defined by previously published cut-off scores (categorical approach). Dependent measures include markers of emotional distress (i.e. general anxiety, social phobia, depression,

negative/positive mood, and loneliness) and inhibition (i.e. interaction anxiety, emotional inhibition, and behavioral inhibition). We hypothesized that social inhibition is associated with other measures of inhibition and that it has value as vulnerability factor for emotional distress and inhibition in patients with CAD (Denollet, 2013; Grande et al., 2010).

Method

Participants and procedures

The sample consists of 173 patients with post-acute CAD, who were recruited between January and June 2013 during their regular check-up visit to the cardiac outpatient clinic. Patients were eligible to participate if they had a diagnosis of CAD and were >18 years of age; patients with a history of psychiatric illness other than affective or anxiety disorders and patients who were unable to complete the questionnaires due to language difficulties were excluded. All patients received written information about the study and signed informed consent. Subsequently, they received our questionnaire at the outpatient clinic and were asked to return it by mail within 2 weeks. Approval for this study was obtained from the institutional psychology ethics committee.

Sociodemographic and lifestyle characteristics

Sociodemographic variables included age, sex, educational level, and marital status. Lifestyle variables included smoking, alcohol consumption, and body mass index (BMI). Information on these variables was derived from purpose-designed questions in the questionnaire. Smoking and alcohol consumption were assessed using the questions "do you smoke?" and "do you consume alcohol?" and could be answered with yes or no. BMI was calculated using self-reported length and weight.

To assess patients' physical and mental health status, the 12-item Short Form Health Survey (SF-12) was used. The SF-12 is a generic health-related quality of life (HRQoL) instrument that uses a subset of 12 items from the SF-36 (Ware et al., 1996). The SF-12 consists out of two scales, a physical scale and a mental scale. Cronbach's alpha of the SF-12 yielded .77 for this sample.

Continuous and categorical measures of Type D personality

Type D personality was assessed with the 14-item Type D Scale (DS14; Denollet, 2005). The items on this scale are rated on a 5-point Likert scale ranging from 0 (false) to 4 (true) and can be divided into two subscales: negative affectivity (e.g. "I am often irritated") and social inhibition (e.g. "I find it hard to start a conversation"). A standardized cut-off of $\geqslant$10 on one of the subscales indicates either high negative affectivity or high social inhibition. Type D personality is defined with a score of $\geqslant$10 on both subscales. Cronbach's alpha of this scale is .88/.86 and the 3-month test–retest reliability amounts .72/.82 for the negative affectivity and social inhibition subscale, respectively (Denollet, 2005). In the current sample, Cronbach's alpha was .87 for both subscales. Based on the quadrants defined by negative affectivity and social inhibition cut-off scores, we were able to identify four subgroups: a reference group that is low on social inhibition and negative affectivity (both social inhibition <10 and negative affectivity <10), a group that is high on social inhibition only (social inhibition $\geqslant$10 and negative affectivity <10), a group that is high on negative affectivity only (negative affectivity $\geqslant$10 and social inhibition <10), and a Type D group (both negative affectivity $\geqslant$10 and social inhibition $\geqslant$10).

Measures of emotional distress

Depressive symptoms. The 9-item Patient Health Questionnaire (PHQ-9) was used to assess depressive symptoms. This questionnaire scores each of the 9 *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; DSM-IV) depression criteria on a 4-point Likert scale

from 0 (not at all) to 3 (nearly every day) (Kroenke et al., 2001). A cut-off score ⩾10 was used to classify patients with clinically relevant depressive symptoms. The questionnaire has a sensitivity of 88 percent and a specificity of 88 percent with this cut-off (Kroenke et al., 2001). The PHQ-9 is therefore a reliable and valid measure of depression severity. Cronbach's alpha was .80 in this dataset.

Negative and positive mood states. Negative and positive mood states were measured using the Global Mood Scale (GMS). This self-report questionnaire consists of 10 negative and 10 positive mood terms which have to be rated on a 5-point Likert scale from 0 (not at all) to 4 (very). Examples of negative mood terms are "exhausted" and "helpless" and examples of positive mood terms are "active" and "lively." The total score on each subscale ranges from 0 to 40, with a higher score indicating more negative or positive mood. Both subscales of the GMS are internally consistent (Denollet, 1993). Cronbach's alpha was .94 for negative mood and .91 for positive mood in the current sample.

General anxiety. Anxiety symptoms were measured using the 7-item Generalized Anxiety Disorder scale (GAD-7). Items on this scale are rated on a 4-point Likert scale from 0 (not at all) to 3 (almost daily) (e.g. "Over the last 2 weeks, how often have you felt nervous, anxious or on edge?"), with total scores ranging from 0 to 21 (Spitzer et al., 2006). The GAD-7 is a reliable and valid scale, with a cut-off value of ⩾10 that is indicative of clinically relevant anxiety symptoms. The sensitivity and specificity of this questionnaire are satisfactory using this cut-off value (89% and 82%, respectively; Spitzer et al., 2006). Cronbach's alpha for the GAD-7 was .88 in the current sample.

Social phobia. The Social Phobia Scale (SPS) was used to assess the fear of being scrutinized during routine activities. This questionnaire is corresponding to the *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed.; DSM) descriptions of Social Phobia (Mattick and Clarke, 1998). In this study, we used the SPS11, the 11-item version of the SPS (Kupper and Denollet, 2012). This scale is rated on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely). Hence, total scores range from 0 to 44, with higher scores indicating higher levels of social phobia. An example of the SPS11 is "I am afraid that other people stare at me when I walk down the street." Cronbach's alpha was .83 in this study.

Loneliness. The 10-item University of California, Los Angeles Loneliness Scale (UCLA-R-S) was used to measure loneliness. This scale is rated on a 4-point Likert scale ranging from 1 (never) to 4 (very often) and includes items like "My social relationships are superficial" and "I do not belong" (Russell, 1996). Total scores range from 10 to 40 and with a higher score indicating more loneliness. The UCLA-R-S is a reliable scale, with internal consistency ranging from .89 to .94 and a 1-year test–retest reliability of $r = .73$ (Russell, 1996). In the current sample, Cronbach's alpha was .76.

Measures of inhibition

Interaction anxiety. The Social Interaction Anxiety Scale (SIAS) was used to measure feelings of discomfort and tension in social situations (Mattick and Clarke, 1998). In this study, we used the 10-item Social Interaction Anxiety Questionnaire (SIAS10; Kupper and Denollet, 2012). This scale is rated on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely) and therefore total scores range from 0 to 40. Higher scores indicate higher levels of interaction anxiety. An example of the SIAS10 is "I have difficulties making eye contact with others." Cronbach's alpha was .93 in this study.

Emotional inhibition. The Emotional Control Questionnaire (ECQ) is a 56-item scale that assesses emotional control. Emotional control can be defined as the tendency to inhibit the expression of emotional responses (Roger and Najarian, 1989). This scale consists out of four factors, comprising 14 items each (i.e. Rehearsal,

Emotional Inhibition, Aggression Control, and Benign Control). In this study, we used the Dutch version of the Emotional Inhibition subscale. This subscale includes items such as "I seldom show how I feel about things" and "When someone upsets me, I try to hide my feelings." Items are scored as present or not and the higher someone's total score, the higher the level of emotional inhibition (Roger and Najarian, 1989). Cronbach's alpha for this subscale was .73 in the present sample.

Behavioral inhibition. To measure behavioral inhibition, we used the 4-item Behavioral Inhibition Scale (BIS). This scale addresses inhibition related to shyness, communication, fearfulness, and smiling (Gest, 1997). This scale includes items such as "I feel shy if I have to talk with a stranger." These are scored as present or not, with total scores ranging from 4 (i.e. not apprehensive, not shy, and very sociable when meeting an unfamiliar person) to 16 (i.e. very apprehensive and shy, and not capable of initiating social interaction with an unfamiliar person). Cronbach's alpha was .71 in this study.

Statistical analysis

Sample characteristics were calculated for the total sample and for the four subgroups based on the two subscale cut-offs of the DS14 (i.e. reference group: low on social inhibition and negative affectivity, SI: only social inhibition $\geqslant$10, NA: only negative affectivity $\geqslant$10, Type D: both social inhibition and negative affectivity $\geqslant$10). Chi-square tests and *F*-tests were used to examine differences between the four subgroups on categorical and continuous sample characteristics.

To investigate the dimensionality of the Type D components, we conducted an exploratory factor analysis (Oblimin rotation) of the sum scores of social inhibition and negative affectivity subscales together with sum scores of distress measures (depression, negative/positive mood, general anxiety, social phobia, and loneliness) and inhibition measures (interaction anxiety, emotional and behavioral inhibition). Bartlett's test of sphericity and the Kaiser–Meyer–Olkin measure of sampling adequacy (KMO index) were examined to evaluate whether the data fulfilled the assumptions to carry out a factor analysis. The number of factors to extract was based on eigenvalues and screeplot data. We used maximum likelihood as extraction method.

Next, we performed a series of multiple regression analyses to investigate the contribution of social inhibition and negative affectivity (continuous Type D measure) and their interaction as independent correlates of emotional distress and inhibition measures. We were primarily interested in the effect of social inhibition when controlled for negative affectivity, as some consider the social inhibition component to be redundant (Ketterer , 2010). To avoid multicollinearity due to the correlations between social inhibition, negative affectivity, and Type D personality, social inhibition and negative affectivity total scores were centered. Subsequently, an interaction term was calculated based on the centered variables. These analyses were controlled for the effects of sex, age, educational level, and marital status because of their established relationship with anxiety and depression (Furmark, 2002; Gottlieb et al., 2004).

Finally, we adopted a categorical approach by comparing scores of the four personality type subgroups on emotional distress and inhibition. Analyses of variance (ANOVAs) were used to analyze overall subgroup differences and standardized Pearson residuals to determine which subgroups differed significantly. All analyses were performed using IBM SPSS 22.0 for Windows (IBM SPSS Inc., Chicago, IL, USA).

Results

Sample characteristics

In total, 251 consecutive patients with post-acute CAD received questionnaires. The response rate was 69 percent, with 173 patients giving informed consent and returning a

Table 1. Demographic and clinical characteristics for the total sample and four personality subgroups.

	# Missing	Total sample $n=173$	Personality subgroups [a]				χ^2/F [b]	p
			Reference $n=77$	SI only $n=35$	NA only $n=24$	Type D $n=35$		
Women, *n* (%)	0	40 (23)	11 (14)	8 (23)	11 (46)	8 (23)	10.6	**.01**
Age (mean ± SD)	0	69.1 ± 9.6	68.6 ± 8.7	69.5 ± 10.9	67.7 ± 9.8	69.7 ± 10.1	0.28	.84
With partner, *n* (%)	0	144 (83)	64 (83)	32 (91)	19 (79)	32 (91)	10.3	.80
Higher education, *n* (%) [c]	0	107 (62)	49 (64)	23 (66)	15 (63)	20 (57)	8.8	.45
Smoking, *n* (%)	0	14 (8)	9 (12)	1 (3)	3 (13)	1 (3)	4.5	.21
Alcohol use, *n* (%)	0	113 (65)	51 (66)	26 (74)	15 (63)	20 (57)	2.4	.50
Body mass index (mean ± SD)	3	27.6 ± 4	27.9 ± 4.3	27.3 ± 3.6	26.8 ± 4	27.6 ± 3.8	.54	.66
Physical health status (mean ± SD) [d]	1	44.1 ± 11	46.8 ± 10.8	45.1 ± 10.7	43 ± 9.7	38.4 ± 10.9	5.1	**.002**
Mental health status (mean ± SD) [d]	1	47.5 ± 10.6	51.1 ± 8.6	50.9 ± 8.7	43.3 ± 11.2	39.4 ± 10.7	15.3	**<.001**

[a] Reference: no social inhibition and no negative affectivity (SI−/NA−); SI: social inhibition only (SI+/NA−); NA: negative affectivity only (SI−/NA+); Type D: both social inhibition and negative affectivity (SI+/NA+).
[b] χ^2/F: for categorical variables χ^2 is shown, and for continuous variables F-value is shown.
[c] Higher education: vocational education level or higher.
[d] Physical and mental health status: measured with 12-item Short Form Health Survey (SF-12).
$p \leq .05$ are presented in bold.

completed questionnaire. Patients with any missing values on socio demographic or psychological variables ($N=22$) were not different from patients without missing values ($N=151$) regarding sex ($p=.30$), marital status ($p=.38$), educational level ($p=.53$), smoking behavior ($p=.14$), alcohol use ($p=.11$), BMI ($p=.14$), physical health status ($p=.86$), and mental health status ($p=.71$). Therefore, we analyzed data based on available cases.

Table 1 displays demographic and lifestyle characteristics of the total sample and stratified by personality subgroups. The average age of the total sample was 69 ± 9.6 years and 77 percent were men. There were sex differences between the personality subgroups. Post hoc analyses showed that there were more women in the negative affectivity group, compared to the three other groups. There were also significant group differences in physical ($p=.002$) and mental ($p<.001$) health status between the four groups ($F=5.1$, $p=.002$; $F=15.3$, $p<.001$, respectively). Post hoc analyses indicated that patients in the negative affectivity and Type D groups reported significantly worse physical and mental health status, as compared to patients in the other groups.

Dimensional approach: two-factor structure of SI and NA measures

According to the KMO index (0.85) and Bartlett's test of sphericity ($p<.001$), data on social inhibition, negative affectivity, distress measures, and inhibition measures fulfilled the assumptions to perform a factor analysis of sum scores. There were three factors with eigenvalues >1 (explaining 66% variance), but the screeplot showed a clear break after the second factor. Therefore, we decided to retain two factors that explained 58 percent of the variance (Table 2). This dimensional analysis was consistent with previous research, showing a two-factor model of "negative affectivity" and "social inhibition" personality domains. Negative affectivity (DS14), depression (PHQ-9), positive and negative mood states (GMS), and general anxiety (GAD-7) loaded highest on the first factor.

The second factor was defined by high loadings on social inhibition (DS14), interaction anxiety (SIAS10), behavioral inhibition (BIS), emotional inhibition (ECQ-2), social phobia (SPS11), and loneliness (UCLA-R-S). One scale showed a cross-loading >.30 on both factors, namely, general anxiety (.55/.32). The

Table 2. Construct validity of the social inhibition domain: exploratory factor analysis of sum scores.

	Factor I	Factor II
Negative affectivity (DS14-NA)	**0.56**	0.24
Depression (PHQ-9)	**0.92**	−0.13
Negative mood (GMS-NA)	**0.91**	−0.11
Positive mood (GMS-PA)	**−0.56**	−0.09
Anxiety (GAD-7)	**0.55**	0.32
Social inhibition (DS14-SI)	0.01	**0.76**
Interaction anxiety (SIAS10)	0.18	**0.73**
Behavioral inhibition (BIS)	−0.05	**0.62**
Emotional inhibition (ECQ-2)	−0.10	**0.61**
Social phobia (SPS11)	0.27	**0.41**
Loneliness (UCLA-R-S)	0.24	**0.36**
Eigenvalue	4.9	1.6
% of variance	44%	14%

Bold values reflect scales selected for each factor. DS-14: 14-item Type D Scale; NA: negative affectivity; PHQ-9: 9-item Patient Health Questionnaire; GMS: Global Mood Scale; PA: positive affectivity; GAD: Generalized Anxiety Disorder; SIAS: Social Interaction Anxiety Scale; BIS: Behavioral Inhibition Scale; ECQ-2: Emotional Inhibition subscale from the Emotional Control Questionnaire; SPS: Social Phobia Scale; UCLA-R-S: University of California, Los Angeles Loneliness Scale.

negative affectivity and social inhibition factors were moderately correlated ($r = .48$).

Continuous approach: effects of NA, SI and their interaction

The first model included covariates sex, age, partner status, and educational level. Female sex was positively associated with negative mood ($p = .03$), general anxiety ($p = .003$), and social phobia ($p = .01$). Higher educational level was positively associated with behavioral inhibition ($p = .01$) and loneliness ($p = .001$) and having a partner was positively associated with social phobia ($p = .004$).

Model 2 (i.e. centered negative affectivity and social inhibition scores, together with covariates) showed significant positive main effects of negative affectivity for depression ($p < .001$), negative mood ($p < .001$), general ($p < .001$), and interaction anxiety ($p < .001$) and significant negative main effects for positive mood ($p = .002$; Table 3). Social inhibition had significant positive main effects for general ($p = .007$) and interaction anxiety ($p < .001$), emotional ($p < .001$) and behavioral inhibition ($p < .001$), social phobia ($p < .001$), and loneliness ($p = .001$) and negative main effects for positive mood ($p = .004$; Table 4). For all distress and inhibition measures, the models significantly improved after including negative affectivity and social inhibition ($p < .001$; Tables 3 and 4).

Next, we expanded the model with the interaction term of negative affectivity and social inhibition (centered variables). All main effects for negative affectivity (i.e. depression, negative and positive mood, general anxiety, interaction anxiety, social phobia, and loneliness) and for social inhibition (i.e. positive mood, general anxiety, interaction anxiety, emotional and behavioral inhibition, social phobia, and loneliness) remained significant in Model 3 (Table 3 and 4). There was also a significant interaction effect of Type D for social interaction anxiety ($p = .001$) and a trend toward an effect for general anxiety ($p = .09$). For other distress and inhibition measures, the continuous interaction yielded no significant effects.

Categorical approach: NA, SI, and Type D subgroups

Next, we adopted a categorical approach by comparing the four personality subgroups on emotional distress (Figure 1(a)). These groups differed significantly in depression ($F = 8.29$), negative mood ($F = 11.71$), positive mood ($F = 5.70$), and general anxiety ($F = 23.46$), with p-values $\leqslant .001$. Post hoc analyses indicated that the Type D group reported higher levels of depressive symptoms and negative mood ($p < .001$) and lower levels of positive mood ($p = .02$) as compared to the other three groups (Figure 1(a)). Both the Type D and negative affectivity groups had higher levels of general anxiety ($p = .02$) compared to the other two groups.

The personality subgroups also differed significantly in interaction anxiety ($F = 25.05$), emotional inhibition ($F = 13.4$), behavioral inhibition ($F = 12.95$), social phobia ($F = 10.85$),

Table 3. Associations of continuous negative affectivity (NA) and social inhibition (SI) scores with markers of emotional distress.

	Depression PHQ-9		Negative mood GMS-NA		Positive mood GMS-PA		General anxiety GAD-7	
	β	p	β	p	β	p	β	p
Model 1								
Female sex	.15	.07	.18	**.03**	−.10	.23	.24	**.003**
Age	−.14	.09	−.08	.30	.002	.98	−.13	.10
Having a partner	.03	.75	.02	.85	−.07	.44	.05	.56
Higher education	.05	.59	.15	.07	−.10	.24	.12	.12
	$F = 1.79$; $R^2 = .05$; $p = .13$		$F = 2.71$; $R^2 = .07$; $p = .03$		$F = 1.17$; $R^2 = .03$; $p = .33$		$F = 4.27$; $R^2 = .10$; $p = .003$	
Model 2								
NA centered	.48	**<.001**	.48	**<.001**	−.27	**.002**	.57	**<.001**
SI centered	.07	.35	.09	.22	−.24	**.004**	.17	**.007**
Female sex	.04	.59	.07	.38	−.04	.65	.11	.08
Age	−.12	.09	−.07	.34	−.01	.93	−.11	.07
Having a partner	.02	.74	.01	.85	−.07	.39	.05	.45
Higher education	−.03	.68	.08	.29	−.04	.61	.03	.65
	$F = 9.88$; $R^2 = .29$; $\Delta F = 24.91$; $\Delta R^2 = .24$; $p < .001$		$F = 11.30$; $R^2 = .32$; $\Delta F = 25.59$; $\Delta R^2 = .25$; $p < .001$		$F = 5.86$; $R^2 = .19$; $\Delta F = 14.81$; $\Delta R^2 = .16$; $p < .001$		$F = 24.37$; $R^2 = .50$; $\Delta F = 57.99$; $\Delta R^2 = .40$; $p < .001$	
Model 3								
NA centered	.48	**<.001**	.47	**<.001**	−.26	**.003**	.56	**<.001**
SI centered	.06	.47	.07	.37	−.21	**.01**	.14	**.03**
NA × SI	.05	.52	.08	.31	−.10	.23	.10	.09
Female sex	.04	.59	.06	.38	−.04	.66	.11	.08
Age	−.12	.09	−.07	.35	−.01	.90	−.11	.07
Having a partner	.03	.70	.02	.78	−.08	.33	.06	.37
Higher education	−.03	.65	.07	.32	−.03	.66	.02	.72
	$F = 8.49$; $R^2 = .29$; $\Delta F = .41$; $\Delta R^2 = .002$; $p = .52$		$F = 9.83$; $R^2 = .32$; $\Delta F = 1.03$; $\Delta R^2 = .005$; $p = .31$		$F = 5.25$; $R^2 = .20$; $\Delta F = 1.44$; $\Delta R^2 = .008$; $p = .23$		$F = 21.53$; $R^2 = .51$; $\Delta F = 2.76$; $\Delta R^2 = .009$; $p = .09$	

PHQ-9: Patient Health Questionnaire; GMS-NA: Negative Mood subscale from Global Mood Scale; GMS-PA: Positive Mood subscale from Global Mood Scale; GAD-7: General Anxiety Disorder.
$p \leq .05$ are presented in bold.

and loneliness ($F = 11.08$), again with p-values <.001 (Figure 1(b)). Post hoc analyses indicated that the Type D group reported significantly higher levels of interaction anxiety compared to the other three groups ($p = .03$) and that the social inhibition group reported significantly higher levels of interaction anxiety compared to the reference group ($p < .001$) and negative affectivity group ($p = .049$). Furthermore, the Type D group reported significantly more emotional and behavioral inhibition ($p = .01$) compared to the three other groups and the social inhibition group reported significantly more inhibition compared to the reference group ($p < .001$, see Figure 1(b)). Finally, the reference group with low negative affectivity and social inhibition had the lowest levels of social phobia ($p = .02$) and loneliness ($p = .006$).

Discussion

The findings of this study indicated that social inhibition is a distinct component from negative affectivity within the Type D personality construct and that both social inhibition and negative affectivity are associated with increased

Table 4. Associations of continuous negative affectivity (NA) and social inhibition (SI) scores with markers of inhibition.

	Interaction anxiety SIAS10		Emotional inhibition ECQ-2		Behavioral inhibition BIS		Social phobia SPS 11		Loneliness UCLA-R-S	
	β	*p*	*β*	*p*	*β*	*p*	*β*	*p*	*β*	*p*
Model 1										
Female sex	.07	.39	−.16	.054	.06	.45	.21	**0.01**	.02	.85
Age	−.001	.99	.02	.77	.09	.26	−.14	.08	−.01	.87
Having a partner	.07	.4	.14	.1	−.02	.82	.24	**.004**	−.02	.83
Higher education	.09	.27	.13	.13	.22	**.01**	.01	.88	.28	**.001**
	$F = 0.91$; $R^2 = .02$; $p = .46$		$F = 1.94$; $R^2 = .05$; $p = .11$		$F = 2.86$; $R^2 = .07$; $\mathbf{p = .03}$		$F = 5.02$; $R^2 = .12$; $\mathbf{p = .001}$		$F = 3.24$; $R^2 = .08$; $\mathbf{p = .01}$	
Model 2										
NA centered	.26	**<.001**	.08	.31	.03	.75	.35	**<.001**	.26	**.001**
SI centered	.54	**<.001**	.45	**<.001**	.46	**<.001**	.18	**.02**	.33	**<.001**
Female sex	.003	.97	−.19	**.01**	.05	.53	.12	.1	−.05	.49
Age	.008	.9	.03	.72	.09	.2	−.13	.07	−.004	.95
Having a partner	.08	.22	.14	.053	−.01	.87	.24	**.001**	−.01	.84
Higher education	.01	.88	.07	.31	.18	**.01**	−.05	.45	.22	**.003**
	$F = 21.29$; $R^2 = .47$; $\Delta F = 60.57$; $\Delta R^2 = .44$; $\mathbf{p < .001}$		$F = 9.34$; $R^2 = .28$; $\Delta F = 22.99$; $\Delta R^2 = .23$; $\mathbf{p < .001}$		$F = 10.07$; $R^2 = .29$; $\Delta F = 22.81$; $\Delta R^2 = .22$; $\mathbf{p < .001}$		$F = 10.87$; $R^2 = .31$; $\Delta F = 19.90$; $\Delta R^2 = .19$; $\mathbf{p < .001}$		$F = 10.79$;$R^2 = .31$; $\Delta F = 23.90$; $\Delta R^2 = .23$; $\mathbf{p < .001}$	
Model 3										
NA centered	.23	**.001**	.09	.26	.03	.74	.36	**<.001**	.26	**.001**
SI centered	.48	**<.001**	.47	**<.001**	.47	**<.001**	.21	**.009**	.33	**<.001**
NA × SI	.21	**.001**	−.08	.28	−.02	.82	−.09	.21	.006	.93
Female sex	<.001	.99	−.19	**.01**	.05	.53	.12	.1	−.05	.49
Age	.01	.82	.02	.74	.09	.2	−.13	.07	−.004	.95
Having a partner	.1	.12	.14	.07	−.01	.85	.23	**.002**	−.01	.85
Higher education	−.002	.98	.08	.28	.18	**.01**	−.05	.49	.22	**.003**
	$F = 21.02$; $R^2 = .50$; $\Delta F = 10.83$; $\Delta R^2 = .04$; $\mathbf{p = .001}$		$F = 8.18$; $R^2 = .28$; $\Delta F = 1.16$; $\Delta R^2 = .006$; $p = .28$		$F = 8.58$; $R^2 = .29$; $\Delta F = .055$; $\Delta R^2 < .001$; $p = .82$		$F = 9.58$; $R^2 = .32$; $\Delta F = 1.57$; $\Delta R^2 = .007$; $p = .21$		$F = 9.19$; $R^2 = .31$; $\Delta F = .007$; $\Delta R^2 < .001$; $p = .93$	

SIAS10: Social Interaction Anxiety Scale; ECQ-2: Emotional Inhibition subscale from Emotional Control Questionnaire; BIS: Behavioral Inhibition Scale; SPS11: Social Phobia Scale; UCLA-R-S: Revised University of California Los Angeles Loneliness Scale.
$p \leqslant .05$ are presented in bold.

vulnerability for emotional distress in patients with CAD. These findings are important because some have questioned the validity of the inhibition component in Type D (Grande et al., 2010) or have even argued that social inhibition is merely an epiphenomenon of negative affectivity (Ketterer, 2010). In our study, exploratory factor analysis clearly indicated a two-factor model of "social inhibition" (associated with inhibition and loneliness) and "negative affectivity" (associated with depression and mood states) as underlying, latent personality traits, which is in line with findings of previous factor analytic studies (Beutel et al., 2012; Kudielka et al., 2004; Kupper et al., 2013; Pelle et al., 2009). In addition, a large international study of 6222 patients with ischemic heart disease confirmed the cross-cultural validity of social inhibition as a distinct personality trait in the context of Type D (Kupper et al., 2013). Importantly, the findings of this study also support the added value of social inhibition in describing and identifying psychological risk profiles in patients with CAD.

We included multiple anxiety measures to assess symptoms of general anxiety (GAD-7),

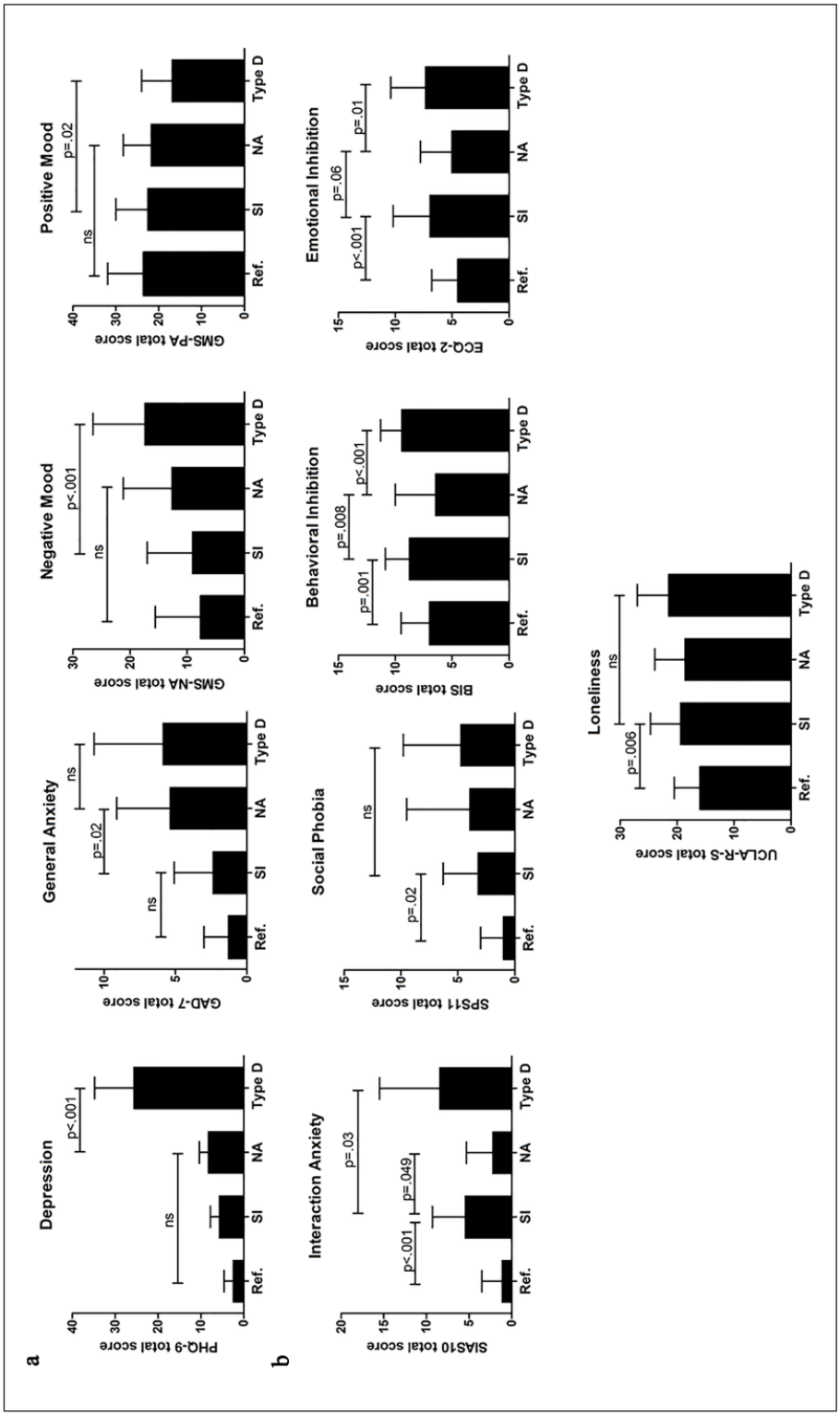

Figure 1. (a) Personality subgroups and markers of emotional distress and (b) personality subgroups and markers of inhibition.
PHQ-9: Patient Health Questionnaire; GMS-NA: Negative Mood subscale from the Global Mood Scale; GMS-PA: Positive Mood subscale from the Global Mood Scale; GAD-7: General Anxiety Disorder scale; Ref: reference group (i.e. scoring low on both NA and SI); SI: Social Inhibition group (i.e. scoring high on SI, low on NA); NA: Negative Affectivity group (i.e. scoring high on NA, low on SI); Type D: Type D personality group (i.e. scoring high on both NA and SI); SIAS10: Social Interaction Anxiety Scale; BIS: Behavioral Inhibition Scale; ECQ-2: Emotional Inhibition subscale from the Emotional Control Questionnaire; SPS I 1: Social Phobia Scale; UCLA-R-S: University of California Los Angeles Loneliness Scale; Ref: reference group (i.e. scoring low on both NA and SI); SI: Social Inhibition group (i.e. scoring high on SI, low on NA); NA: Negative Affectivity group (i.e. scoring high on NA, low on SI); Type D: Type D personality group (i.e. scoring high on both NA and SI).

social phobia (SPS11), and interaction anxiety (SIAS10). Factor analysis of total scale scores indicated cross-loadings of these anxiety measures across the two Type D components. General anxiety (.73) and social phobia (.48) loaded highest on the negative affectivity factor, with cross-loadings above .35 on the inhibition factor, while interaction anxiety loaded .70 on the inhibition factor with a cross-loading of .43 on negative affectivity. Evidence from the general population also revealed that social inhibition was more strongly associated with interaction anxiety than with social phobia, whereas negative affectivity was more strongly associated with social phobia and, more specifically, its "loss of control" facet (Kupper and Denollet, 2014). These findings indicate that both Type D components are closely related to different manifestations of anxiety and may help to explain why Type D personality has been shown to be a clinically important predictor for the severity (Schiffer et al., 2008) and persistence (Versteeg et al., 2015) of anxiety in cardiac patients.

Next, we shifted from a dimensional to a continuous approach of the Type D traits. Social inhibition was not only significantly associated with several inhibition measures (interaction anxiety, emotional and behavioral inhibition, social phobia, and loneliness) but also with some distress measures (positive mood and general anxiety) while adjusting for negative affectivity. Negative affectivity was significantly associated with the well-known distress measures (depression, anxiety, and mood), but also with interaction anxiety, social phobia, and loneliness, while adjusting for social inhibition. There was a significant negative affectivity by social inhibition interaction effect for social interaction anxiety and a trend toward an effect for general anxiety. For other measures, there were no significant interaction effects. However, all social inhibition and negative affectivity main effects remained significant in the interaction model. Smith (2011) indicated that results for main effects of negative affectivity and social inhibition provide useful contributions to the field. In this study, the significant main effects of social inhibition are conflicting with Ketterer's (2010) view of social inhibition as an epiphenomenon of negative affectivity. Based on our results, it can be concluded that the social inhibition component is not redundant, as it has predictive value for several inhibition and distress measures.

Finally, we used classification in personality subgroups to investigate the additional value of high levels of social inhibition regarding psychosocial risk factors. We applied a prototypical approach by imposing the Type D model, since the DS14 has the highest reliability in the trait range around the cut-off (Emons et al., 2007). This categorical approach indicated that Type D personality, characterized by high levels of both social inhibition and negative affectivity, may lead to significantly higher depression and negative mood scores and lower positive mood scores as compared to subgroups with only high negative affectivity or high social inhibition. Previous research in patients with CAD also showed that Type D patients had higher levels of depressive symptoms as compared to patients with negative affectivity only (Bunevicius et al., 2014). Recent findings from the Maastricht Study confirmed that depressive symptoms as well as depressive disorder were significantly more prevalent in participants with Type D personality versus participants with negative affectivity or social inhibition only (Van Dooren et al., 2016), and a large study of patients with diabetes also reported that people with Type D personality experienced more symptoms of depression and loneliness as compared to those scoring high on negative affectivity or social inhibition alone (Nefs et al., 2015). These findings further support the notion that the combination of social inhibition and negative affectivity within the Type D construct may have unique value.

Our findings are supported by previous research, which indicated an association between several inhibition measures and cardiovascular disease, showing a relationship between social anxiety/insecurity and hypertension (Räikkönen et al., 2001) and susceptibility to myocardial infarction (Shen et al., 2008),

between social avoidance and cardiovascular morbidity and mortality (Berry et al., 2007). More recent functional magnetic resonance imaging (fMRI) and laboratory studies gave more insight into these associations, by showing that socially inhibited individuals have different brain activation (Kret et al., 2011), increased hypothalamic-pituitary-adrenal stress responses (Habra et al., 2003), exaggerated cardiovascular and cortisol stress reactions (Bibbey et al., 2015; Gross and Levenson, 1997; Habra et al., 2003; Lam et al., 2009) in response to social threat, compared to individuals with high levels of negative affectivity and low levels of social inhibition. Exaggerated stress responses, in turn, have been associated with the development of cardiovascular morbidity and mortality (Carroll et al., 2003, 2012a, 2012b; Everson et al., 1997; Kapuku et al., 1999; Matthews et al., 2006; Murdison et al., 1998), coronary artery calcification (Hamer et al., 2010), hypertension (Hamer and Steptoe, 2012), and cardiovascular disease risk (Girod and Brotman, 2004). Therefore, early identification of socially inhibited patients may be helpful to recognize patients with CAD at increased risk and to promote better health outcomes in these patients. The 7-item social inhibition subscale of the DS14 may be used as a quick and valid assessment of social inhibition levels (Denollet, 2005).

Overall, the present findings show that social inhibition cannot be inferred from measures of negative affectivity, depression, or anxiety, but rather should be assessed in its own right. Unfortunately, this is not common practice in behavioral research on CAD. The fact that the socially inhibited patients in our study reported significantly higher levels of interaction anxiety and emotional/behavioral inhibition compared to patients with high negative affectivity is consistent with a multifaceted model of social inhibition that was recently proposed (Denollet, 2013). According to this model, social inhibition is associated with interpretation biases toward social threats (cognitive facet), interaction anxiety, suppressed anger, emotional inhibition (affective facet), and behavioral inhibition (behavioral facet). These three correlates of social inhibition may contribute to one another in a reciprocal fashion (Denollet, 2013). A factor analytical study has indicated that cognitive and behavioral correlates load high on the social inhibition component of Type D personality, while affective correlates showed cross-loadings with the negative affectivity component of Type D personality (Grande et al., 2010).

The results of this study should be interpreted with some limitations in mind. The cross-sectional design of this study precludes any conclusions about causality of the observed relationships. The great majority of our sample was male and all participants were diagnosed with CAD. Therefore, our results may not be generalizable to women with CAD or to other cardiac populations. Although all patients suffered from post-acute CAD, we are not aware of the exact time span between the acute coronary event and completion of the questionnaire. Due to the lack of comparison groups, we were not able to assess whether our findings are specific to CAD or a more general reflection of chronic disease or healthy aging. Strengths of this study include the analysis of Type D in a sensitive manner. Dimensional, continuous, and categorical Type D scores were investigated, which is in accordance with Smith's (2011) recommendations. In this way, variable-centered as well as person-centered analyses were executed and justice was done to the heterogenic nature of the population with respect to Type D personality (Denollet et al., 2010; Laursen and Hoff, 2006). Another strength of this study is the use of an elaborative set of markers of emotional distress and inhibition, with some markers being relatively less used in previous research on cardiac patients (e.g. SIAS10, SPS11, GMS, ECQ-2, BIS, and UCLA-R-S). This elaborative set of distress markers enabled us provide more evidence for the content of the negative affectivity component (i.e. related to depression, anxiety, negative and positive affect) and to explore the content social inhibition component (i.e. using multiple inhibition measures). Furthermore, it enabled us to investigate the influence of negative affectivity, social inhibition, and Type D on a broad set of emotional distress and inhibition measures.

Research suggests that Type D personality may be related to important cardiovascular outcomes (Garcia-Retamero et al., 2016; Grande et al., 2012). The aim of this study was to improve our understanding of the social inhibition trait within the Type D framework and its value regarding increased vulnerability to psychosocial stress in CAD. The use of an elaborative set of both frequently and infrequently employed questionnaires, together with multiple analysis approaches (i.e. dimensional, continuous and categorical), supports the notion that social inhibition is distinct from negative affectivity and that it may have unique value within the Type D construct. Previous research suggests that the assessment of Type D may promote the early identification of individuals, who are at high risk for negative health outcomes (Denollet et al., 2010, 2013; Grande et al., 2012), including anxiety (Schiffer et al., 2008; Versteeg et al., 2015) and depression (Bunevicius et al., 2014; Nefs et al., 2015; Van Dooren et al., 2016). This study aimed to explore the content and value of the social inhibition component of Type D and showed that social inhibition has predictive value above negative affectivity for several inhibition measures and some distress measures. According to these findings, it may be concluded that social inhibition is more than an epiphenomenon of negative affectivity.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

Berry JD, Lloyd-Jones DM, Garside DB, et al. (2007) Social avoidance and long-term risk for cardiovascular disease death in healthy men: The Western Electric Study. *Annals of Epidemiology* 17: 591–596.

Beutel ME, Wiltink J, Till Y, et al. (2012) Type D personality as a cardiovascular risk marker in the general population: Results from the Gutenberg health study. *Psychotherapy and Psychosomatics* 81: 108–117.

Bibbey A, Carroll D, Ginty AT, et al. (2015) Cardiovascular and cortisol reactions to acute psychological stress under conditions of high versus low social evaluative threat: Associations with the Type D personality construct. *Psychosomatic Medicine* 77: 599–608.

Booth L and Williams L (2015) Type D personality and dietary intake: The mediating effects of coping style. *Journal of Health Psychology* 20: 921–927.

Bunevicius A, Brozaitiene J, Staniute M, et al. (2014) Decreased physical effort, fatigue, and mental distress in patients with coronary artery disease: Importance of personality-related differences. *International Journal of Behavioral Medicine* 21: 240–247.

Carroll D, Ginty AT, Der G, et al. (2012a) Increased blood pressure reactions to acute mental stress are associated with 16-year cardiovascular disease mortality. *Psychophysiology* 49: 1444–1448.

Carroll D, Ginty AT, Painter RC, et al. (2012b) Systolic blood pressure reactions to acute stress are associated with future hypertension status in the Dutch Famine Birth Cohort Study. *International Journal of Psychophysiology* 85: 270–273.

Carroll D, Ring C, Hunt K, et al. (2003) Blood pressure reactions to stress and the prediction of future blood pressure: Effects of sex, age, and socioeconomic position. *Psychosomatic Medicine* 65: 1058–1064.

Coyne JC, Jaarsma T, Luttik ML, et al. (2011) Lack of prognostic value of Type D personality for mortality in a large sample of heart failure patients. *Psychosomatic Medicine* 73: 557–562.

De Fruyt F and Denollet J (2002) Type D personality: A five-factor model perspective. *Psychology and Health: Official Journal of the European Health Psychology Society (EHPS)* 17: 671–683.

Denollet J (1993) Emotional distress and fatigue in coronary heart disease: The Global Mood Scale (GMS). *Psychological Medicine* 23: 111–121.

Denollet J (2005) DS14: Standard assessment of negative affectivity, social inhibition, and Type D personality. *Psychosomatic Medicine* 67: 89–97.

Denollet J (2013) Interpersonal sensitivity, social inhibition, and Type D personality: How and when are they associated with health? Comment on Marin and Miller (2013). *Psychological Bulletin* 139: 991–997.

Denollet J, Pedersen SS, Vrints CJ, et al. (2013) Predictive value of social inhibition and negative affectivity for cardiovascular events and mortality in patients with coronary artery disease: The Type D personality construct. *Psychosomatic Medicine* 75: 873–881.

Denollet J, Schiffer AA and Spek V (2010) A general propensity to psychological distress affects cardiovascular outcomes: Evidence from research on the Type D (distressed) personality profile. *Circulation Cardiovascular Quality and Outcomes* 3: 546–557.

Dulfer K, Hazemeijer BA, van Dijk MR, et al. (2015) Prognostic value of Type D personality for 10-year mortality and subjective health status in patients treated with percutaneous coronary intervention. *Journal of Psychosomatic Research* 79: 214–221.

Emons WH, Meijer RR and Denollet J (2007) Negative affectivity and social inhibition in cardiovascular disease: Evaluating type-D personality and its assessment using item response theory. *Journal of Psychosomatic Research* 63(1): 27–39.

Everson SA, Lynch JW, Chesney MA, et al. (1997) Interaction of workplace demands and cardiovascular reactivity in progression of carotid atherosclerosis: Population based study. *British Medical Journal* 314: 553–558.

Frasure-Smith N and Lespérance F (2008) Depression and anxiety as predictors of 2-year cardiac events in patients with stable coronary artery disease. *Archives of General Psychiatry* 65: 62–71.

Furmark T (2002) Social phobia: Overview of community surveys. *Acta Psychiatrica Scandinavica* 105: 84–93.

Garcia-Retamero R, Petrova D, Arrebola-Moreno A, et al. (2016) Type D personality is related to severity of acute coronary syndrome in patients with recurrent cardiovascular disease. *British Journal of Health Psychology* 21: 694–711.

Gest SD (1997) Behavioral inhibition: Stability and associations with adaptation from childhood to early adulthood. *Journal of Personality and Social Psychology* 72: 467–475.

Girod JP and Brotman DJ (2004) Does altered glucocorticoid homeostasis increase cardiovascular risk? *Cardiovascular Research* 64: 217–226.

Gottlieb SS, Khatta M, Friedmann E, et al. (2004) The influence of age, gender, and race on the prevalence of depression in heart failure patients. *Journal of the American College of Cardiology* 43: 1542–1549.

Grande G, Glaesmer H and Roth M (2010) The construct validity of social inhibition and the Type D taxonomy. *Journal of Health Psychology* 15: 1103–1112.

Grande G, Romppel M and Barth J (2012) Association between Type D personality and prognosis in patients with cardiovascular diseases: A systematic review and meta-analysis. *Annals of Behavioral Medicine* 43: 299–310.

Grande G, Romppel M, Vesper JM, et al. (2011) Type D personality and all-cause mortality in cardiac patients: Data from a German cohort study. *Psychosomatic Medicine* 73: 548–556.

Gross JJ and Levenson RW (1997) Hiding feelings: The acute effects of inhibiting negative and positive emotion. *Journal of Abnormal Psychology* 106: 95–103.

Habra ME, Linden W, Anderson JC, et al. (2003) Type D personality is related to cardiovascular and neuroendocrine reactivity to acute stress. *Journal of Psychosomatic Research* 55: 235–245.

Hamer M and Steptoe A (2012) Cortisol responses to mental stress and incident hypertension in healthy men and women. *Journal of Clinical Endocrinology and Metabolism* 97: 29–34.

Hamer M, O'Donnell K, Lahiri A, et al. (2010) Salivary cortisol responses to mental stress are associated with coronary artery calcification in healthy men and women. *European Heart Journal* 31: 424–429.

Kapuku GK, Treiber FA, Davis HC, et al. (1999) Hemodynamic function at rest, during acute stress, and in the field: Predictors of cardiac structure and function 2 years later in youth. *Hypertension* 34: 1026–1031.

Ketterer MW (2010) Emotional distress and social relationship dysfunction: The clinical implications of Type D? *Journal of Psychosomatic Research* 69: 91–92.

Kret ME, Denollet J, Grezes J, et al. (2011) The role of negative affectivity and social inhibition in perceiving social threat: An fMRI study. *Neuropsychologia* 49: 1187–1193.

Kroenke K, Spitzer RL and Williams JB (2001) The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine* 16: 606–613.

Kubzansky LD, Cole SR, Kawachi I, et al. (2006) Shared and unique contributions of anger, anxiety, and depression to coronary heart disease: A prospective study in the Normative Aging Study. *Annals of Behavioral Medicine* 31: 21–29.

Kudielka BM, von Kanel R, Gander ML, et al. (2004) The interrelationship of psychosocial risk factors for coronary artery disease in a working population: Do we measure distinct or overlapping psychological concepts? *Behavioral Medicine* 30: 35–43.

Kupper N and Denollet J (2012) Social anxiety in the general population: Introducing abbreviated versions of SIAS and SPS. *Journal of Affective Disorders* 136: 90–98.

Kupper N and Denollet J (2014) Type D personality is associated with social anxiety in the general population. *International Journal of Behavioral Medicine* 21: 496–505.

Kupper N, Pedersen SS, Hofer S, et al. (2013) Cross-cultural analysis of Type D (distressed) personality in 6222 patients with ischemic heart disease: A study from the International HeartQoL Project. *International Journal of Cardiology* 166: 327–333.

Lam S, Dickerson SS, Zoccola PM, et al. (2009) Emotion regulation and cortisol reactivity to a social-evaluative speech task. *Psychoneuroendocrinology* 34: 1355–1362.

Laursen B and Hoff E (2006) Person-centered and variable-centered approaches to longitudinal data. *Merrill Palmer Quarterly* 52: 377–389.

Matthews KA, Zhu S, Tucker DC, et al. (2006) Blood pressure reactivity to psychological stress and coronary calcification in the Coronary Artery Risk Development in Young Adults Study. *Hypertension* 47: 391–395.

Mattick RP and Clarke JC (1998) Development and validation of measures of social phobia scrutiny fear and social interaction anxiety. *Behaviour Research and Therapy* 36: 455–470.

Murdison KA, Treiber FA, Mensah G, et al. (1998) Prediction of left ventricular mass in youth with family histories of essential hypertension. *The American Journal of the Medical Sciences* 315: 118–123.

Nefs G, Speight J, Pouwer F, et al. (2015) Type D personality, suboptimal health behaviors and emotional distress in adults with diabetes: Results from Diabetes MILES-The Netherlands. *Diabetes Research and Clinical Practice* 108: 94–105.

Pelle AJ, Denollet J, Zwisler AD, et al. (2009) Overlap and distinctiveness of psychological risk factors in patients with ischemic heart disease and chronic heart failure: Are we there yet? *Journal of Affective Disorders* 113: 150–156.

Pelle AJ, Pedersen SS, Schiffer AA, et al. (2010) Psychological distress and mortality in systolic heart failure. *Circulation: Heart Failure* 3: 261–267.

Räikkönen K, Matthews KA and Kuller LH (2001) Trajectory of psychological risk and incident hypertension in middle aged women. *Hypertension* 38: 798–802.

Roest AM, Martens EJ, de Jonge P, et al. (2010) Anxiety and risk of incident coronary heart disease: A meta-analysis. *Journal of the American College of Cardiology* 56: 38–46.

Roger D and Najarian B (1989) The construction and validation of a new scale for measuring emotion control. *Personality and Individual Differences* 10: 845–853.

Russell DW (1996) UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. *Journal of Personality Assessment* 66: 20–40.

Schiffer AA, Pedersen SS, Broers H, et al. (2008) Type D personality but not depression predicts severity of anxiety in heart failure patients at 1-year follow-up. *Journal of Affective Disorders* 106: 73–81.

Shen BJ, Avivi YE, Todaro JF, et al. (2008) Anxiety characteristics independently and prospectively predict myocardial infarction in men: The unique contribution of anxiety among psychologic factors. *Journal of the American College of Cardiology* 51: 113–119.

Smith TW (2011) Toward a more systematic, cumulative, and applicable science of personality and health: Lessons from Type D personality. *Journal of Psychosomatic Medicine* 73: 528–532.

Spitzer RL, Kroenke K, Williams JB, et al. (2006) A brief measure for assessing generalized anxiety disorder: The GAD-7. *Archives of Internal Medicine* 166: 1092–1097.

Van Dooren FEP, Verhey FRJ, Pouwer F, et al. (2016) Association of Type D personality with increased vulnerability to depression: Is there a role for inflammation or endothelial dysfunction?: The Maastricht Study. *Journal of Affective Disorders* 189: 118–125.

Versteeg H, Roest AM and Denollet J (2015) Persistent and fluctuating anxiety levels in the 18 months following acute myocardial infarction: The role of personality. *General Hospital Psychiatry* 37: 1–6.

Wang Y, Zhao Z, Gao X, et al. (2016) Type D personality and coronary plaque vulnerability in patients with coronary artery disease: An optical coherence tomography study. *Psychosomatic Medicine* 78(5): 583–592.

Ware J Jr, Kosinski M and Keller SD (1996) A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care* 34: 220–233.

Wiencierz S and Williams L (2016) Type D personality and physical inactivity: The mediating effects of low self-efficacy. *Journal of Health Psychology* 1–10.

Williams L, Abbott C and Kerr R (2016) Health behaviour mediates the relationship between Type D personality and subjective health in the general population. *Journal of Health Psychology* 21: 2148–2155.